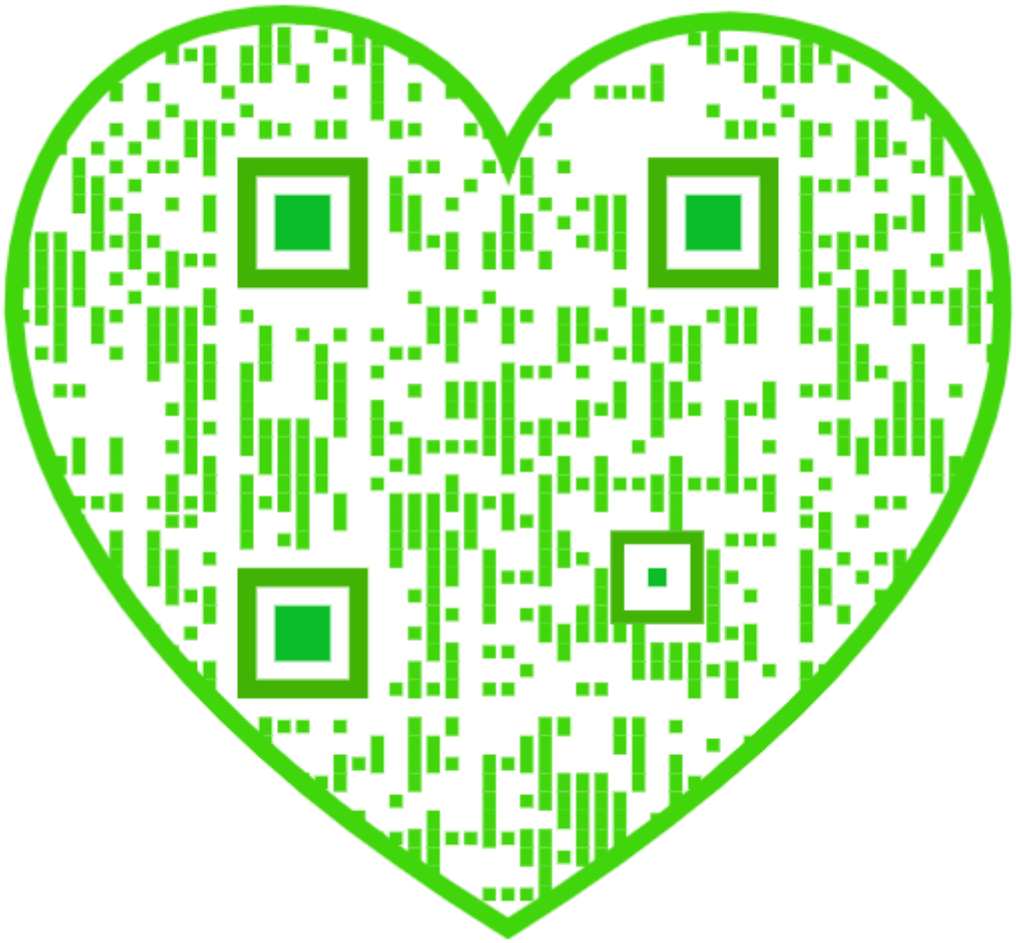

University of Maine.

Maine Agricultural Experiment Station

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PINK AND GREEN APHID OF POTATO

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BULLETIN 242.

PINK AND GREEN APHID OF POTATO.*

(*Macrosiphum solanifolii* Ashmead).

EDITH M. PATCH.

The need for the study of the habits and life cycles of aphids, before a satisfactory basis can be obtained for remedial recommendations, is apparent to anyone familiar with the complexities of such a problem.

Those species that accept but one food plant, depositing their winter eggs upon it and passing their whole life cycle there, usually present no difficulties greater than those of other insect pests and are even easier to combat than many.

But those aphids that select one kind of plant upon which to pass the fall, winter and spring and a different kind for the summer generations, frequently so change their manner of life to suit the two environments that it behooves us to look sharply lest we miss a link here or there in their life cycles, but even here we need reckon with only two plants.

When, however, in addition to two favorite food plants, a species of aphid will accept others not botanically related, the problem is complicated by a new element for every different food plant.

This latter condition is the case with the pink and green aphid of potato. When work with this species was first undertaken at the Maine Agricultural Experiment Station, the only food plants recorded for it were two plants belonging to the night-shade family,—the "pepper vine" and the potato. A glance at the food plant list in this bulletin will show that the insect concerned has really a broad taste in botanical juices and will imbibe freely of the sap from numerous sources, each of which deserves consideration in economic work with this aphid.

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*Papers from the Maine Agricultural Experiment Station Entomology No. 81.

LIFE HISTORY.

The pink and green aphid of potato is found in the spring upon rose bushes, feeding on the succulent growth and especially abundant near the flower buds. Unlike many species of plant-lice, migration with this insect may occur through wingless as well as winged individuals. The winged ones take flight, and the others, if they are near enough, walk over to potato plants. This occurs in Maine ordinarily from the first to the middle of July, when a very few scattered individuals may be seen upon the potato. Upon this plant they seem to find conditions ideal for growth and increase enormously, often before the last of August covering the tender tips and blossom stalks thickly with their colonies. At this time a single female may produce more than 50 young in 2 weeks, and it takes, in warm weather, about 2 weeks after birth for a female of this species to attain maturity and begin to produce young. A glance at figure 48 will show the result of a heavy infestation of 14 days duration upon the potato plant.

By the middle of September the fall migration is over and the aphids have deserted the potato fields. The indoor studies with this insect indicate that when it leaves the potato it prefers the rose, but will colonize upon a variety of plants, part of which are common weeds. This seems more like a dispersal from the potato than a "return migration" in the sense this term is used with reference to those aphids which accept only two kinds of food plant—the first for the fall, the overwintering egg and the spring, and the second for the summer months. However, the rose seems to be the favorite and it is probable in Maine that this serves most commonly for the fall generations of the potato aphid. The last generation of the year consists in the wingless, egg-laying females and the winged males,—or the so-called "true sexes" which appear in Maine about September 20 and only at this one time, all the other generations consisting entirely of viviparous females. The insectary observations of 1907 showed that under indoor conditions, the true sexes may be produced and the overwintering eggs may be deposited on both potato and shepherd's purse. It is likely that this generation can be produced on other accepted food plants also. No evidence has been found in the field, however, that the true sexes or eggs occur normally upon the potato, for the aphids

leave that food plant earlier in the season when out of doors. In the insectary the eggs were placed indiscriminately on leaves and stalks. These are pellucid green at first and later become glistening brownish black.

It is not known upon how great a range of food plants this aphid will develop in the spring. In Maine it has never yet been collected during this season upon anything but rose, which would indicate that this is the favorite overwintering host plant and the one ordinarily chosen for the deposition of the egg in the fall.

On October 9, 1908, great numbers of winged viviparous females and winged males and wingless oviparous females were found on Japanese rose bushes on the Maine Campus. They were for the most part on the ventral surface of the leaves. The winged viviparous females were presumably the fall migrants and mothers of the true sexes.

The stem mothers or females hatching from the overwintering eggs, were abundant upon these same bushes the next May and by the thirteenth of the month were nearly mature and were feeding at the half-opened leaf buds. On June 3 the progeny of the first generation, or the stem mothers, consisted of mature alate and apterous viviparous females as well as immature aphids of both the second and third generation. Usually by the first of July only scattered colonies remain upon the rose and by this time the summer generation may be found upon the potato.

ECONOMIC SIGNIFICANCE.

During certain summers enormous numbers of the pink and green potato aphid have appeared over wide areas in Aroostook County, the vines being attacked to an injurious extent in the vicinity of Houlton and elsewhere. The colonies cluster thick on stem, leaf and blossom stalk, blighting the stems and drying the terminal leaves as is shown in figures 47 and 48. The time of severest attack apparently varies somewhat, but the infestation in Maine has not been excessive before early August and is over with before the middle of September. Under conditions favorable to aphid growth, an attack of less than two weeks' duration suffices to kill the potato stalk for a distance of 4 to 6 inches from the tip, and the growth of the tubers on plants thus weakened must necessarily be affected. Aside from

the direct weakening of the plant due to the loss of sap and the withering of the tissue, the danger to the health of a plant thus attacked by plantlice is considerable. Although exceedingly minute, the beak of the plantlouse makes a wound which becomes in a short time surrounded by a discolored area, readily detected by the unaided eye. As these wounds extend for some little distance into the plant, a favorable location for the entrance of bacterial or fungus disease is thus secured even where the infestation of plantlice is not excessive enough to wither the tips of the stalk. Moreover it is perfectly possible for insects to carry fungus spores from diseased to healthy plants. Where the plantlice are abundant the leaves are covered with honey dew which is soon attacked by a dark fungus, and which together with the molted skins adhering to the sticky substance, gives the leaves an unhealthy appearance and must interfere with their natural function.

DISTRIBUTION.

Macrosiphum solanifolii has been recorded from Canada, Florida, Maine and California, and from various intermediate localities. Apparently it might be expected to occur in any of our states.

DESCRIPTION.

Recognition characters: In general *Macrosiphum solanifolii* is a large species either green or pink. The apterous forms are somewhat inclined to drop from the plant when disturbed. The abdomen is not marked with dark, but is ordinarily clear in color either pink or green, though sometimes late in the season individuals may be found with a mottling part pink and part green. The mature forms are rather glistening, but in the stage previous to the last molt the insect usually has a mid-dorsal line of dark green or pink (according to the color of the individual) while the rest of the dorsum is paler by virtue of a very slight powdery deposit. This appearance is more noticeable in bright light. The beak is short, usually, not or barely reaching the second coxa, though certain collections have been taken with beaks a little longer. The cornicles are characterized by reticulations at the tip. This reticulation holds true for all the mature individuals,—alate and apterous viviparous females, oviparous

females, and males,—whether of the green or pink variety, and regardless of the food plant upon which they have developed. The cornicles of the immature individuals are not so marked. The antennae of the apterous females are a little swollen at the proximal part of III, where a few sensoria are placed; those of the alate females have the sensoria in a single row not extending to the distal tip of III. The wing veins are clear cut and well defined though slender.

The foregoing are the general recognition marks. There is no structural difference between the spring and the fall individuals great enough to lead one to think they might be different species; though there is a range in size, influenced by food plant or other conditions, great enough to cause hesitation in determining certain collections unless the progenitors are known. The measurements, therefore, in the following descriptions can only be taken as approximate.

Macrosiphum solanifolii. Winged viviparous female, green variety.—Head yellowish green. Beak typically barely reaching second coxa, though in some collections a little longer. Antennae, proximal segments pale green, distal segments dark; length of segments: III, .88 to .96 mm.; IV, .76 to .9 mm.; V, .64 to .72 mm.; VI, base .16 to .2 mm.; VI, spur .96 to 1.12 mm.; total length I to VI, 3.6 to 4.05 mm. III with single row of sensoria somewhat irregular in size numbering 18 or a few more or less, not extending to distal end. Prothorax and thorax light yellowish green, lobes brownish. Wings hyaline, veins dark brown, very slender and clear cut, stigma pale brown. Total wing expansion 8.1 mm. Legs with proximal part of femora and tibiae pale, tarsi and distal part of femora and tibiae dark. Tarsi .16 to .2 mm. Abdomen light green unmarked dorsally or ventrally. Cornicles, with proximal portion green and distal portion dark brown, imbricated for more than three-fourths its length but strongly reticulated at tip, cylindrical, length .95 mm. or about five times length of tarsus. Cauda light green, ensiform, length .48 mm. or about one-half length of cornicles. Total length of body to distal tip of cauda and exclusive of antennae 2.9 to 3.37 mm.

Winged viviparous female, pink variety.—Head light yellowish. Antennae with I and II light yellowish, rest dark. Sensoria as with the green variety. Porthorax and thorax light yellowish pink. Abdomen pale pink. Cornicles light yellow with tips dusky and strongly reticulated. Cauda pink. Measurements the same as with the green variety.

Apterous viviparous female.—Color either pink or green as with the winged viviparous form. Antennae, length of segments: III, .8 to .96 mm.; IV, .72 to .88 mm.; V, .56 to .72 mm.; VI, base .16 to .2 mm.; VI spur .96 to 1.2 mm.; total length of segments I to VI, average about 4.05 mm. III slightly swollen at basal third where 1 to 5 sensoria occur. Cor-

nicles .96 to 1.04 mm. in length, and strongly reticulated at tip about one-fifth the distance. Cauda .56 mm. Total length of body to distal tip of cauda and exclusive of antennae, 4.05 mm.

Apterous oviparous female.—Head pale, nearly white. Antennae with proximal joints pale, distal half dark. Length of segments: III, .68 to .88 mm.; IV, .56 to .68 mm.; V, .52 to .64 mm.; VI, base .16 mm.; VI, spur .96 to 1.04 mm.; total antennal length I to VI average about 3.6 mm. III with about 3 to 6 sensoria. Prothorax and thorax pale like head. Legs with femora and tibiae, proximal portion pale, distal portion dusky. Tarsi dark, .16 mm. long. Hind tibiae conspicuously darker and much swollen and thickly set with sensoria. Abdomen light salmon pink. Cornicles pale at base, distal half dark and reticulated at tip; length .6 to .8 mm. Cauda salmon pink, ensiform, length .32 to .4 mm. Total body length to tip of cauda, antennae excluded, 2.13 to 2.15 mm. The size of the hind tibiae of this form makes it readily distinguished from the apterous viviparous form and young, even to the unaided eye.

The pink variety has been described because these predominate among the oviparous females. The color scheme of the green and yellow forms can be determined merely by substituting these colors for the salmon pink of the individual described, the dark coloration being the same for all three.

Winged male.—Head and antennae dark brown. Length of antennal segments: III, .72 to .8 mm.; IV, .48 to .64 mm.; V, .48 to .6 mm.; VI, base .16 mm.; VI, spur 1.04 to 1.28 mm.; total antennal length I to VI, 2.93 to 3.60 mm. Sensoria numerous on III, usually none on IV, and an irregular row of them nearly the whole length of V. Prothorax and thorax dark brown. Wings hyaline, veins dark and very slender, stigma pale brown. Legs brown, darker at tips. Abdomen greenish or brown. Cornicles pale brown, dark distally and reticulated, cylindrical, .48 to .56 mm. long. Total body length exclusive of antennae and cornicles, 1.12 to 1.57 mm. The thorax is large and strong, the abdomen much shrunken, making the cornicles seem conspicuously long. The male is described from individuals taken in copulation, in order that no mistake as to the identity of the species might occur.

INDOOR STUDIES.

This potato aphid is amenable to laboratory or greenhouse conditions, being very easy to rear indoors. In 1907 successful colonies were reared by the writer on garden peas and shepherd's purse in the insectary, the insects being originally collected from potato. The notes concerning these follow:

July-October, 1907. By starting potatoes in the insectary often, the aphids were supplied with fresh plants which were colonized by the individuals deserting the leaves and stalks they had rendered sickly.

Buckwheat was sown among the potato plants in the insectary and about 200 young and clean plants of shepherd's purse were put into trays. Peas were also sown at the same time. By the time the buckwheat and peas were well up about 100 fresh potato plants were available, and the *M. solanifolii,* deserting the older potato stalks, colonized thoroughly the fresh potato vines, pea vines, and the shepherd's purse apparently with no preference. Both winged and wingless forms were found for the rest of the season rearing contented progeny upon potato, and shepherd's purse, and also upon the young pea vines. Except for stray individuals which, of course, would be found upon everything in the crowded insectary, the buckwheat remained apparently untouched for feeding purposes. Whether *M. solanifolii* would have accepted the blossom tips of the older buckwheat or not was not demonstrated, as the buckwheat, although it lived, did not make much growth. (On vigorous succulent buckwheat in the field a collection of apparently *solanifolii* was taken at Houlton, Me., Aug. 31, 1907.)

October 11, 1907. Insectary search showed the *Macrosiphum* eggs near some of the oviparous forms both upon potato and shepherd's purse (*Capsella Bursa-pastoris.*) Many of the eggs were the glistening brownish black of well hardened eggs but some were pellucid green, showing that they had very recently been deposited. They were upon the plants indiscriminately on leaves and stalks. Males and oviparous females were present upon both these plants.

The appearance of the oviparous females and the deposition of eggs with the uncaged material at practically the same time as that of the forms that had been prisoners for 2 months would indicate that these dates are about normal. In the insectary the dispersion from overcrowded potato stalks to fresh plants seemed to take place irregularly and not at any stated times, the condition of the infested plant apparently influencing these movements. The fact that they seemed to accept the fresh potato plants almost as readily as the peas or the shepherd's purse might seem to indicate that if a similar succession of new potatoes were supplied them in the field they might not seek another host even there. As it is a wholesale migration has taken place each of the seasons these plantlice have been under observation.

July 7, 1915. Specimens of *Macrosiphum solanifolii* were collected from about the flower buds of Japanese rose on the campus (72-15).

72-15 (a) July 7, mature apterous viviparous females collected from Japanese rose were placed on potato in the laboratory. Both the pink and the green varieties were used. These settled at once. July 13,—pink and green individuals both still feeding, and a vigorous colony of green nymphs present. July 20. Progeny of 72-15 (a) present in colonies of pink and green young.

72-15 (b) July 7,—a few alate viviparous females collected from Japanese rose were placed on potato plants in the laboratory. Both the pink and the green variety used. July 9,—one pink female with 4 pink young, one green female with several green young. July 13,—pink and green females still feeding, and pink and green nymphs numerous. July 19,—plant sickly but aphid colonies thriving. Nine mature apterous pink females (progeny of the alate forms of July 7 (72-15 (b)) removed to fresh potato plant under number of 72-15 (b) (b).

72-15 (b) (b) July 19,—9 mature apterous pink daughters of alates (collection 72-15 (b)) placed on fresh potato plant. August 2,—the progeny of aforesaid 9 individuals now number approximately 500. All are pink, 35 of these have attained their growth, 20 being winged and 15 apterous.

* * * * *

The descendants unto several generations, of 72-15 which had been collected from Japanese rose, were kept on a succession of fresh potato plants in the laboratory until about the middle of August, when both the winged and wingless aphids began to get restless. The infested plants were taken down to the insect greenhouse and left uncovered. Stems of cut Japanese rose were kept near them in jars of water.

On September 15, these potato plants still had numerous aphids upon them but many had left and established thriving colonies of progeny upon the rose cuttings; goosefoot, *Chenopodium album;* redroot pigweed, *Amaranthus retroflexus;* shepherd's purse, *Capsella Bursa-pastoris;* several varieties of cultivated asters; and sow thistle, *Sonchus oleraceous.*

Both winged and wingless viviparous mature females of both the green and pink color varieties were found feeding upon all

the plants listed in the foregoing paragraph and good colonies of young both pink and green, were also feeding readily upon all these plants. They were along the tender terminal stems, on fresh leaves or in the case of the asters particularly abundant upon the blossom petals.

Whether this aphid would accept so varied a diet immediately upon leaving the rose in the spring or not we do not know. After a summer upon potato it is apparently ready to play the role of a general feeder, judging from the wide range of food plants just recorded.

Maine collection data for eight seasons indicate that *solanifolii* prefers decidedly the rose in the spring and the potato in the summer, for it is commonly abundant upon these two and has not yet been conspicuous upon other vegetation here. There is however, no reason to suppose that any aphid will accept indoors a plant which it would not feed upon out of doors if conditions were favorable, and it might easily be present in small colonies without being detected.

FOOD PLANTS.

GRAMINEAE. Grass Family.

Zea mays L. Britton, W. E. 1913. 12th Rept. St. Ent. of Conn.

IRIDACEAE. Iris Family.

Iris sp. cultivated. Patch, Edith M., 1912. Me. Agr Expt. Sta. Bul. 202.
Gladiolus sp. Patch, Edith M. 1912. Me. Agr. Expt. Sta. Bal. 202.

POLYGONACEAE.

Fagopyrum esculentum Moench. Buckwheat. Patch, Edith M. 1907, field collection, (16-07).

CHENOPODIACEAE. Goosefoot Family.

Chenopodium album L. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

AMARANTHACEAE. Amaranth Family.

Amaranthus retroflexus L. Redroot pigweed. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

CRUCIFERAE. Mustard Family.

Brassica Rapa L. Turnip. Patch, Edith M. 1905, field collection (62-05).
Capsella Bursa-pastoris (L) Patch, Edith M. 1907. Me. Agr. Expt. Sta. Bul. No. 147, p. 244.

ROSACEAE. Rose Family.

Pyrus malus (Hill). Apple. Baker, A. C. 1915. Letter of May 4: "Last season we found the green variety feeding on apple. . . . I had noted the species previously on apple in the pink form, as well as the pink one on potatoes."

Rosa species. Patch, Edith M. 1914 (1915). Bul. 233. Me Agr. Expt. Sta. Japanese rose; 1915, Notebook record for July 13, apterous viviparous form on wild rose.

LEGUMINOSAE. Pulse Family.

Phaseolus vulgaris L. Bean. Patch, Edith M. 1905, field collection (53-05).

Pisum sativum L. Garden pea. Patch, Edith M. 1907. Me. Agr. Expt. Sta. Bul. No. 147, p. 244. Greenhouse test with progeny from potato colonies.

SOLANACEAE. Nightshade Family.

Physalis species. Ground cherry. Webster, R. L. 1915. Iowa Bulletin 155.

Solanum jasminoides Paxt. Pepper vine. Ashmead, Wm. 1882. Canadian Entomologist.

Solanum melongena L. Egg plant. Chittenden, F. H. 1915. In letter of June 22 "Collected at Washington between June 17 and 21, 1915."

Solanum tuberosum L. Potato. Fletcher, James. 1905. Ann. Rept. on Expt. Farms for 1904: Patch, Edith M. 1907-1915. Bulletins of Me. Agr. Expt. Sta.: Davis, J. J. 1911, Jour. Ec. Ent.; Britton, W. E. 1913 12th Rept. St. Ent. of Conn. Webster, R. L. 1915. Iowa Bul. 155.

COMPOSITAE. Composite Family.

Aster cultivated. Patch, Edith M. 1915 Notebook record for Sept. 15. Greenhouse material.

Cineraria sp. Ross, William A. 1914. In letter of Feb. 26, greenhouse material, "taken from flower stalks and foliage."

Lactuca sp. Davidson, W. M. 1912. Jour. Ec. Ent.

Sonchus oleraceous. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

NOTES.

The type specimens of *solanifolii* are presumably lost. The writer once called at the Smithsonian Museum to consult Dr. Wm. Ashmead as to the possibility of referring to these and received the information that "the type is knocking around in a vial somewhere, probably dry by this time.' Then he continued with cordial interest: "If you have a large green *Macrosiphum* on *Solanum* you have *solanifolii* all right."

Upon this evidence the potato pest of Maine fields was identified with the "pepper vine" aphid of Florida, after comparing it with specimens which were being determined by Mr. Pergande as *solanifolii*.

The original description of the wingless female accords with the species generally known as *solanifolii* except that "style short, conical," is hardly applicable to any mature representative of the genus concerned. For this reason it seems likely that the specimen recorded may have been in the last nymphal stage, at which time the style or cauda would be short and conical. As was customary at that time, the spur of the sixth antennal joint is designated as the seventh.

The so-called male of the original description is the winged form of some other species of aphid.

It is an interesting fact that this species, though widely known in this country as a rose aphid and existing in various collections under a commonly recognized manuscript name, has not been described from the rose, although its identity with *solanifolii* remained unsuspected and it has for some years been supposed to be an undescribed rose species.

Considering the range of food plants this aphid accepts it would be surprising if the synonomy when it is finally worked out did not contain a long list of names. It is certain that it has been recorded for *pisi* at times and it is possible that some of the food plants accredited to *pisi* really belong to the dietary of *solanifolii*.

The present paper is not concerned with the question as to whether *solanifolii* should fall as a synonym of some well known European species. It seems safer to confine the problem to America, at least until we learn to recognize this species on our own territory regardless of the foodplant from which it is collected.

LITERATURE.

1882. Ashmead, Wm. *Siphonophora solanifolii.* On the Aphididae of Florida with descriptions of new species. (Paper No. 3.). Can. Ent. Vol. 14, p. 92. Original description of apterous viviparous form. The so-called "male" is a winged form ot some other species.

1905. Fletcher, James. *Nectarophora solanifolii.* Ann. Rept. on Expt. Farms for 1904, p. 228.

1907. Patch, Edith M. *Nectarophora solanifolii.* In Insect Notes for 1906. Me. Agr. Expt. Sta., Bulletin 134, p. 215.

1907. Fletcher, James. *Nectarophora solanifolii.* Ann. Rept. on Expt. Farms for 1906, p. 210.

1907. Patch, Edith M. *Nectarophora solanifolii.* The Potato Plant Louse. Me. Agr. Expt. Sta., Bulletin 147, pp. 235-257. Figs. 25-33.

1911. Patch, Edith M. *Macrosiphum solanifolii.* Two species of Macrosiphum. Me. Agr. Expt. Sta., Bulletin 190, pp. 81-92. Figs. 59-66. Compared with *M. destructor.*

1911. Davis, J. J. *Macrosiphum solanifolii.* List of Aphididae of Illinois. Journal of Economic Entomology, Vol. 4, p. 330.

1912. Davidson, W. M. *Macrosiphum solanifolii.* Aphid notes from California. Journal of Economic Entomology. Vol. 5, p. 411. Recorded from wild lettuce.

1912. Patch, Edith M. *Macrosiphum solanifolii.* Aphid Pests of Maine. Me. Agr. Expt. Sta. Bulletin 202, p. 178. Apparently this species collected from *Gladiolus* and cultivated *Iris.*

1913. Britton, W. E. *Macrosiphum solanifolii,* 12th Rept. of the State Entomologist of Connecticut for 1912, p. 294. Reported from leaves of corn and potatoes.

1914. Patch, Edith M. *Macrosiphum solanifolii.* Maine Aphids of the Rose Family. Me. Agr. Expt. Sta., Bulletin 233, p. Recorded from Japanese rose.

1915. Webster, R. L. *Macrosiphum solanifolii.* Potato Insects. Agr. Expt. Sta., Iowa St. Col. of Agric. and Mech. Arts. Bul. 155, pp. 400-406. Recorded from two species of wild ground cherry. (*Physalis*).

NATURAL CONTROLS.

It is always well to bear in mind concerning the injury inflicted by any plantlouse that so many elements of uncertainty enter into the career of these insects that it is quite impossible to predict whether such a pest is likely to trouble us for two or many consecutive years, or succumb to some adverse condition and practically disappear for a long time.

The weather, for instance, plays an important part in the welfare of aphids, heavy rains washing the tender forms from the plants, and cold days retarding the rate of their increase.

Certain climatic conditions are favorable to fungus parasitism which may sweep out the plantlice from a large area in a few days' time.

Then, too, in some seasons, predaceous and parasitic insects appear in numbers sufficient to render any artificial remedial measures superfluous.

REMEDIAL MEASURES.

Clean culture. Since the pink and green potato aphid passes the winter in the egg stage presumably upon a great variety of weeds near infested potato fields, the practice of fall plowing commends itself, and also the burning over of weedy places in the vicinity of potato fields in the fall or early spring. As it seems not impossible, although it has not been observed in the field, that belated individuals might under certain conditions

remain upon the potato vines and deposit overwintering eggs there, the custom common through Aroostook County of burning the old stalks is commendable in this connection.

As the aphid feeds upon a wide range of plants, the foregoing measures should be observed relative to other crops grown in rotation on the same ground.

Sprays. Cultivated roses should be sprayed with some good tobacco decoction if found to be infested with these plantlice in the spring. This is both for the health of the rose bushes as a direct measure and for the potato crop indirectly, because none of the aphids which are killed on the rose can migrate to the potato fields later on.

If the infestation upon the potato is excessive a tobacco spray for aphids might be given.

When the trouble is confined to greenhouse plants either tobacco sprays or fumigation can be resorted to according to the experience and preference of the operator.

Formula—Tobacco Decoction.

Tobacco stems or tobacco dust*.....	2 pounds.
Water	4 gallons.

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and appled. Boiling violently drives off the nicotine. If whole-leaf tobacco is used prepare as above, using one pound of tobacco to each four gallons of water. No lime or other alkaline substance should be added to the tobacco *while cooking.* Apply at once or within a few days after making, if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* can be secured through local druggists. The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company,* Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by *The Nikotine Manufacturing Company,* St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.

*Refuse from cigar factories.

There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each 70 gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in proportion of one gallon to 60 or 65 gallons of water. Careful sprayers have usually succeeded in killing plant-lice with this preparation in the proportion of one gallon to each 100 gallons of water. Thoroughness of application is of as much importance as the strength of the material.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 700 or 800 parts of water. Some have been successful with 1 part to 1000 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of a thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to "wet" and "stick" to the bodies of the aphids. For the purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

When other plant enemies besides aphids are present "Combination sprays" are frequently successfully applied. Self-boiled lime-sulphur (8-8-50 cold) may be used adding 1-70 of its volume of *Black Leaf*. On the same basis *Black Leaf* may be combined with Bordeaux (5-5-50) or with lead arsenate or with both together when foes combine against one kind of plant.

Even when the spraying is thoroughly done some of the aphids are likely to escape. Watch should therefore be kept and if the first application seems unsatisfactory, a second treatment in the course of a week is desirable.

When a small quantity of spray is required one teaspoonful of *Black Leaf 40* in one gallon of water is a convenient amount to mix.

Fig. 47. Pink and green aphid on potato stalk. Leaves covered with honey dew, honey dew fungus, and cast skins.

Fig. 48. Potato plant showing the result of 14 days infestation of plantlice on stalks which were previously healthy.

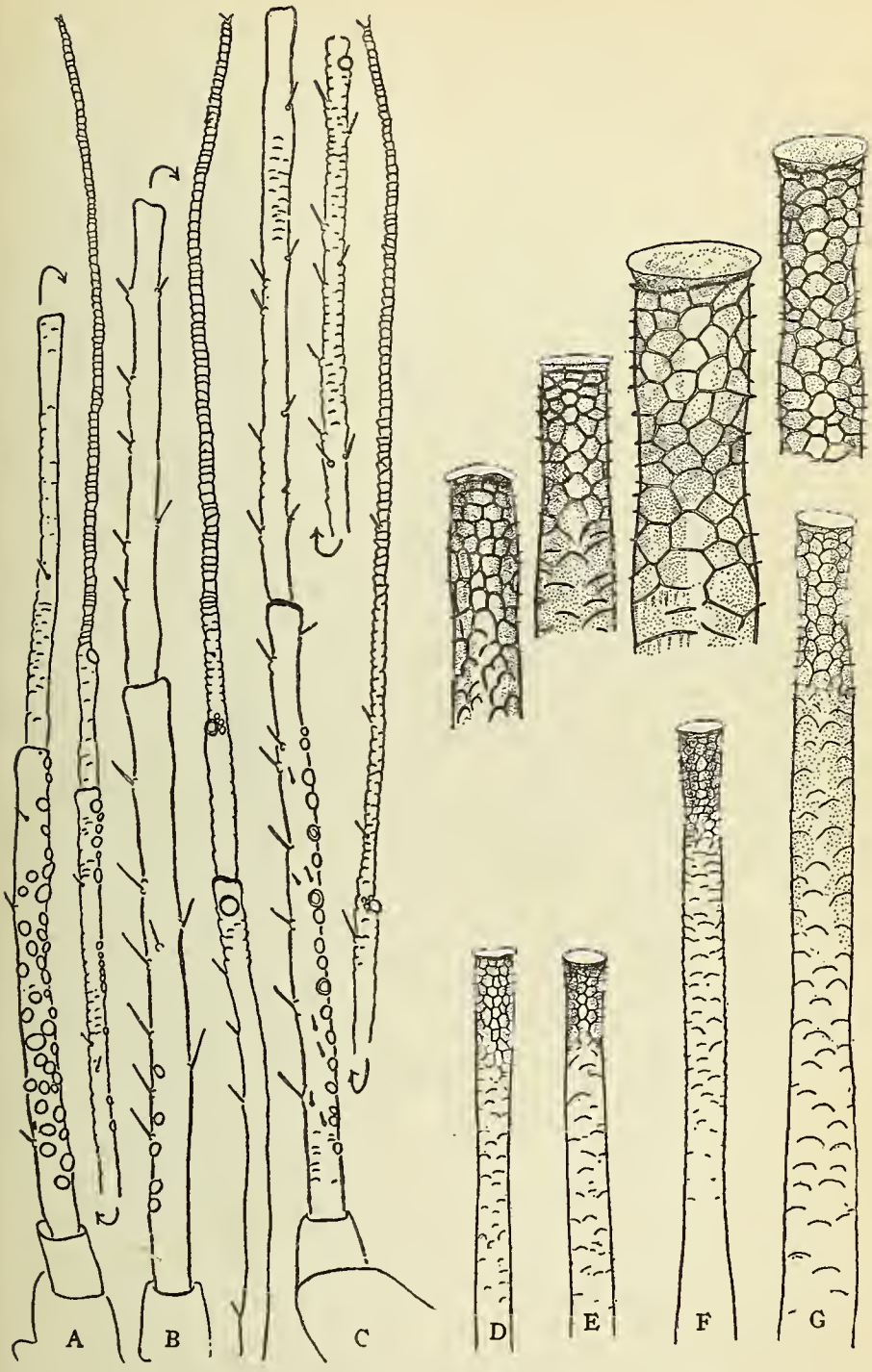

Fig. 49. *Macrosiphum solanifolii,* antennae and cornicles. A, alate male; B, apterous viviparous female; C, alate viviparous female; D, male; E, apterous oviparous female; F, alate viviparous female, pink variety; G, apterous viviparous female, green variety.